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BATHING WATER QUALITY AND HEALTH - II. INLAND RIVER

Russell S. Smith, et al

Environmental Health Center
Cincinnati, Ohio

1952

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QUALITY
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II- INLAND RIVER

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Cincinnati, Ohio

1952

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BATHING WATER QUALITY AND HEALTH

II - INLAND RIVER

A Study of Bathing Water Quality
in the
Ohio River at Dayton, Kentucky
and its
Relation to Health of Bathers.

By

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I a

F.L.

CONTENTS

	Page
I. Introduction	1
A. Origin	1
B. Present Study	2
II. Survey Methods	3
A. Description of Area	3
B. Sanitary Surveys	6
C. Climatological Data	9
D. Water Examinations	9
E. Epidemiological	11
III. Summary of Data	16
A. Bacteriological	16
B. Epidemiological	22
IV. Conclusions	52
V. Appendixes	
A. Individual Laboratory Results	54
B. Survey Forms	60
C. Miscellaneous Data	70

TABLES

1. Bacteriological Results - Cross River Surface Waters	9
2. Epidemiological Survey Coverage	14
3. Nonrecovered Epidemiological Forms	15
4. Summary of Bacteriological Results - Dayton Beach	17
5. Summarized Results - Effect of Raw Sewage Discharge on Ohio River Shore Waters	20
6. Summary of Bacteriological Results - Tacoma Park Pool	21

TABLES, (Continued)

		Page
7.	Daily Swimming Status of Persons Swimming One or More Days	27
8.	Frequency Distribution of Persons, Person-Days, Swimming and Illness	29
9.	Percentage of Total Person-Days for Swimming at Various Locations	30
10.	Number of Illnesses of All Types per 100 Person-Days	31
11.	Percentage Distribution of Persons by Days and Location of Swimming	33
12.	Over-All Age Specific Illness Incidence Rates	36
13.	Observed vs. Expected Illness Incidence by Swimming Groups (First Method)	38
14.	Over-All Illness Incidence Rates per 100 Person-Days by Age and Amount of Swimming	40
15.	Observed vs. Expected Illness Incidence by Swimming Groups (Second Method)	41
16.	Reported Illnesses by Type	42
17.	Observed vs. Expected Illness Incidence by General Illness Type among Swimming Groups	44
18.	Relation of Illness Experience of 940 Ohio River Swimmers to Bacterial Quality of Bathing Water	48
19.	Illness Experience by Type of Illness for Certain Incubation Periods Following Swimming in Ohio River Water of Three Levels of Coliform Density	50

APPENDIX TABLES

Appendix A

1.	Bacteriological Results - Dayton Beach	55
2.	Bacteriological Results - Ohio River at Dayton Beach and Walnut Street	57
3.	Bacteriological Results - Tacoma Park Pool	58

APPENDIX TABLES, (Continued)

Appendix C

Page

1. Frequency Distribution by Sex and Age of Persons, and Person-Days, of Swimming and Illness 71

FIGURES

Figure

1. Location Map 4

2. Sources of Pollution 7

3. Rainfall and Bacteriological Results 19

4. Swimmers, Meteorological Data, and Beach Coliform Densities 24

1. INTRODUCTION

A. Origin. Over a period of years, the people of the United States have become more concerned about the safety of bathing in the natural waters of the country. Many health departments have set limiting standards for "safe" bathing waters. These standards frequently mention physical requirements such as the absence of floating solids, scum, oil, tars and toxic substances, but all are based primarily on bacteriological quality of the water, using the density of organisms of the coliform group as an indicator of sewage pollution. The limiting coliform densities in the various standards vary greatly, and what would be considered an acceptable bathing water in some localities would be condemned as "unsafe" in other areas. These large variations in allowable coliform densities are apparently due to the fact that little direct epidemiological evidence was available to indicate the amount of pollution that would make a natural water dangerous to the health of bathers. Apparently the limits were set to include the better waters of the area and to exclude the poorer waters.

The Public Health Service believed that an attempt should be made to determine the amount of bacterial pollution in a natural water that would make it unfit for bathing, in order that suitable guides of acceptability could be recommended to the various health departments interested in control of bathing places. The first study for this purpose was made in 1948 on the water of Lake Michigan along the Chicago shore line as a part of the Tri-State Survey of Lake Michigan Waters ("Bathing Water Quality and Health. I - Great Lakes," R. S. Smith, T. D. Woolsey and

A. H. Stevenson, Environmental Health Center, Cincinnati, 1951. Hereafter referred to as "Chicago study"). It was realized that one study would be insufficient to provide the information needed, and future studies on bathing waters of different types and varying degrees of pollution were anticipated.

B. Present Study. For the second survey of the series, it was thought desirable to select a bathing water that was considerably more polluted than that at Chicago and preferably one that exceeded the limits allowed under the most liberal existing standards. If the study showed no significant increase in illness among bathers using such polluted water, then many of the existing standards might be considered unduly restrictive. Any significant increase in illness among bathers would indicate bathing water of such quality to be detrimental to health and that any standard to be written should exclude such a water from use.

As in the Chicago study, the amount of illness was to be based on the minor illnesses that might be expected to be caused by contact with, or ingestion of, polluted water. This would require that information on swimming experience and illness be gathered from a large population.

The Ohio River in the vicinity of Cincinnati apparently met the required conditions of a more polluted water, if it were commonly used for bathing. The turbid waters of the midwest rivers do not appeal to the general public for bathing purposes as do the clear waters of large lakes and the ocean. Furthermore, for many years the public has been

led to consider the Ohio as an extremely polluted stream. However, there is a large gravel and sand bar in Dayton, Kentucky, opposite Cincinnati, and it had been noted that on hot summer days this was commonly used as a bathing place by many people. It was believed that a survey of illness incidence in the Kentucky communities adjacent to this beach might yield valuable information. A second commonly used natural bathing water that was relatively unpolluted was not available to provide a control group of bathers, but there was a pool, used by many people from the area, that could be used to furnish comparative data.

After careful consideration of the facts involved, plans were made to conduct a survey, during the summer of 1949, in the cities of Dayton and Bellevue, Kentucky, with the support of the Campbell County Board of Health and the Kentucky State Department of Health.

II. SURVEY METHODS

A. Description of Area. Dayton Beach is a portion of a long, and comparatively wide, sand and gravel bar on the convex side of a large bend of the Ohio River. It is located at the eastern, or upriver, boundary of Dayton, Ky. The portion of the bar commonly used for bathing is about 1,000 feet long. Figure 1 shows the general location of the beach and the adjacent communities.

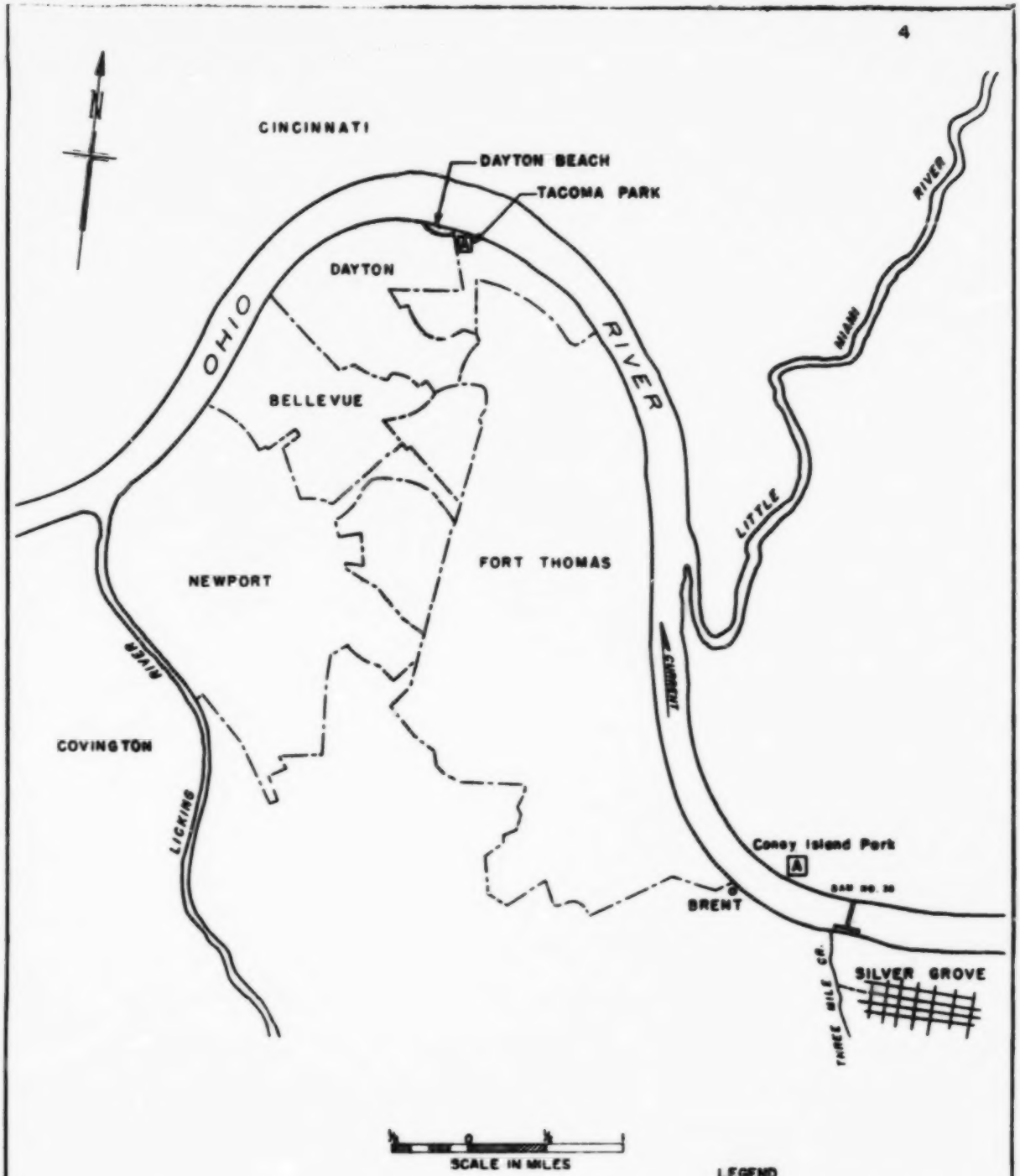

FIGURE 1

BATHING WATER SURVEY

DAYTON, KENTUCKY

LOCATION MAP

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CINCINNATI, OHIO 1951

The beach is not what is commonly understood by a "public bathing beach," as there are no organized facilities for public use. The beach is reached by a rough dirt road across the bottom land from the end of a city street. The area is subject to flooding nearly every spring at time of high water. Due to this annual flooding, a layer of dried silt has been deposited over the sand and gravel of the bar, above the normal high-water mark. The summer pool stage, as maintained by the lock-and-dam system, is about 6 to 8 feet lower than this normal high-water mark.

Dayton and Bellevue are adjacent communities with no pronounced physical division. They both lie to the southwest of, and downstream from, the beach. In general, they are typical small industrial cities, with economic levels varying from poor, adjacent to the river bank, to upper middle class in the newer homes on the hills. The major population is found in the older portions of the communities on the level bench between the river and the hills. Industries in the communities are generally small, with the exception of a watch case plant in Dayton. Dayton, in particular, is an old community and rather static in the main section, which is generally composed of small houses on narrow lots. There are many elderly people in this portion, retired and living on pensions. The 1950 census reports Dayton as having a population of 8,943, and Bellevue a population of 9,036.

Just east of the city limits of Dayton, near the river bank, is Tacoma Park, a small amusement park with a swimming pool as the major attraction. The pool is of concrete and has a capacity of 1,500,000

gallons. The depth varies from about two feet at the shallow end to about ten feet at the deep end, where a diving tower is located. The pool water is recirculated through a purification plant consisting of pressure sand filters and vacuum type gas chlorinators. The water inlet to the purification plant is at the bottom of the deep end and the water is returned to the pool through inlets at the sides and shallow end. A concrete walk about 12 feet wide surrounds the pool.

B. Sanitary Surveys. Dayton Beach is located within that stretch of the Ohio River known as the "Cincinnati Pool" and is about five miles below Dam 36 at the head of the pool. The Cincinnati pool is heavily polluted by the discharge of raw sewage and industrial wastes from Cincinnati and from the Kentucky cities of Fort Thomas, Dayton, Bellevue, Covington and Newport. Most of the sewage from the Kentucky communities and much of that from the Cincinnati area is discharged downstream from Dayton Beach.

During the period of the survey, the river was in pool stage, the gauge heights varying from 11.5 feet to 17.4 feet, with a median gauge height of 12.9. Generally there was an appreciable, although sometimes slight, downstream current, and it is not believed that sewage which entered the river downstream from the beach had any effect on the bacterial densities observed in the beach waters. Figure 2 shows the location of sewer outlets discharging to the river above Dayton Beach.

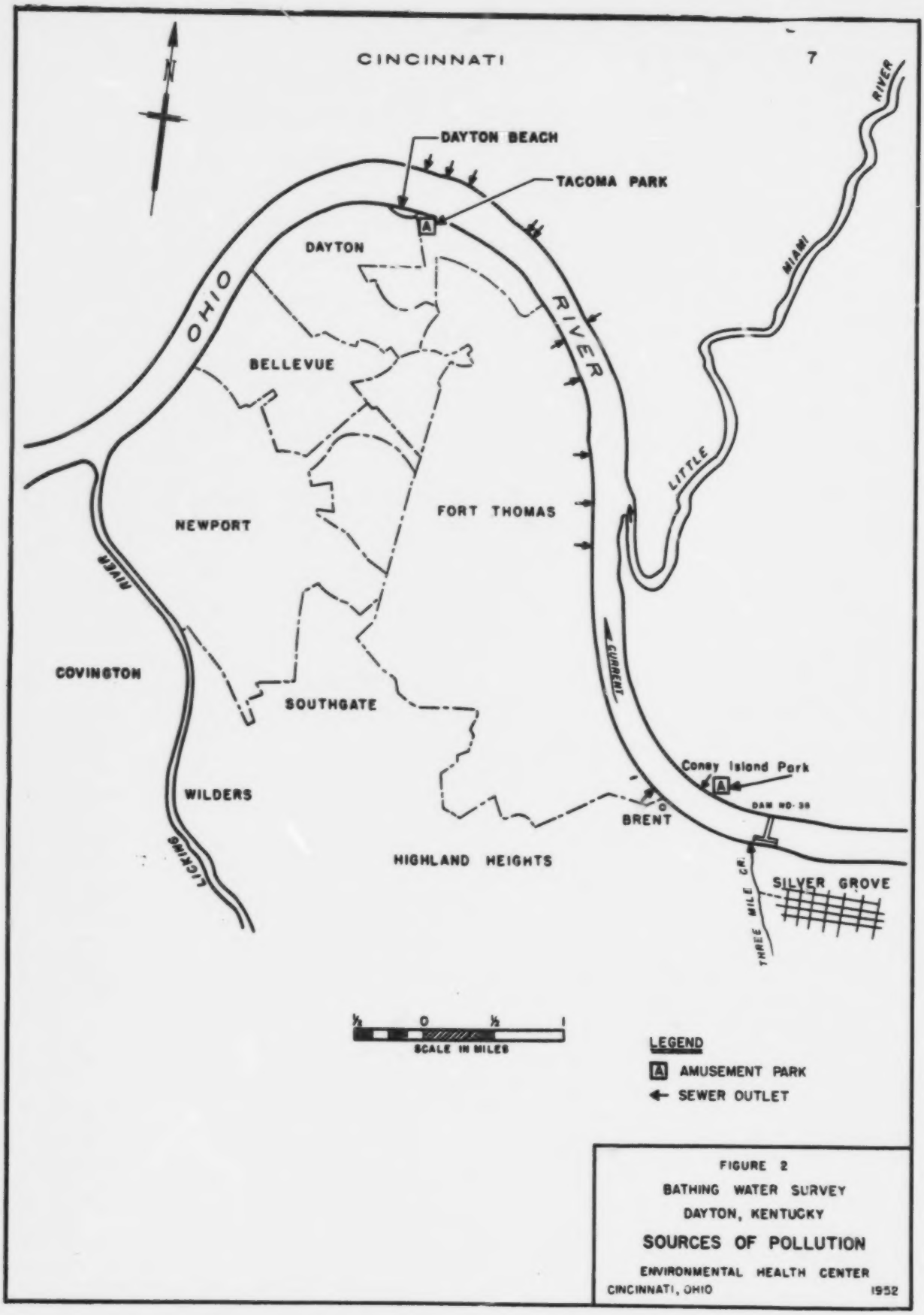

FIGURE 2

BATHING WATER SURVEY

DAYTON, KENTUCKY

SOURCES OF POLLUTION

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Within a distance of 4.8 miles above the beach on the Kentucky side of the river there are six sewers, serving an estimated population of 7,500 in Fort Thomas, that discharge to the river. The nearest of these sewers serves a population estimated at 690 and is 1.5 miles above the beach. The small community of Brent, Kentucky, is located 5.6 miles above the beach but has no sewer system. About 1-1/2 miles above Brent and 7 miles above the beach is Silver Grove with a population of 859 in 1940. The community has a combined sewer system with a connected population of 860 according to a check made in 1948. The sewage flows to a pumping station which discharges to the Ohio River. In case of pumping station failure, there is an overflow from a manhole above the pumping station to Three Mile Creek which enters the Ohio River just below Dam 36 and about 6 miles above the beach. This overflow was in operation when the system was inspected on August 15, 1949.

There is more sewage entering the river above the beach from Ohio than from Kentucky. Just below Dam 36 the Coney Island Amusement Park discharges sewage from the equivalent of 2,700 people. The sewage from an estimated population of 90,000 reaches the Ohio River through the Little Miami River. There are 6 Cincinnati sewers with an estimated connected population of 20,000 discharging to the Ohio River between the mouth of the Little Miami River and a point opposite the beach.

Due to the large reverse bend of the river at Dayton, the channel and the main current cross over to the north, or Ohio, shore just below the mouth of the Little Miami River. This tends to hold the pollution from the Little Miami River and the Cincinnati sewers against the north

bank and away from Dayton Beach. This is clearly shown by the bacteriological results from a set of 6 surface water samples taken on a line across the river at Dayton Beach on July 25. The results of this set of samples are given in Table 1.

Table 1 - Bacteriological Results, Cross-River Surface Waters

Fifth Point Stations	MPN per 100 ml.	
	Coliform	Enterococcus
0 - Ohio shore	130,000	93
1	7,000	23
2	4,600	3.6
3	2,300	3.6
4	4,900	< 3.0
5 - Kentucky shore	3,300	7.2

C. Climatological Data. Data on daily rainfall, temperature variations and river stages were obtained from the U. S. Weather Bureau, Cincinnati office, to determine whether any correlation existed between these factors and the coliform density of the river water and amount of swimming. As the river stage is artificially controlled by a series of dams to maintain a minimum depth for navigation, there was no apparent correlation between gauge height and bacterial densities. There was a correlation between heavy rainfall and bacterial densities.

D. Water Examinations. The bathing waters on the river beach and in the swimming pool were sampled once daily from June 26 to August 19 for determination of coliform and enterococcus densities. Three sample points were established on the beach. These points were set at the upstream, center and downstream limits of the portion of the bar commonly used for bathing. The samples were taken by wading out to

water approximately two feet deep and dipping the sample with a sweeping motion from about 6 inches below the surface. Two sample points were used for the swimming pool, one at the deep end and the other at the center. Thiosulfate was used in all sample bottles to ensure dechlorination of the pool water samples. Residual chlorine determinations were made on the pool water at the time of sampling. Samples were placed in an iced container immediately after collection and kept at a temperature of about 5°C until they reached the laboratory. The samples arrived at the laboratory within four hours after collection. The hydrogen ion concentration was determined colorimetrically and determinations of coliform and enterococcus most probable numbers were made.

The coliform determinations were made in accordance with the confirmed test procedure described in "Standard Methods for the Examination of Water and Sewage," 9th edition (1946). All lactose tubes showing any gas in 24 hours were confirmed in brilliant green bile lactose broth. Negative tubes (no gas) were incubated another 24 hours and any tube showing gas in the second incubation period was confirmed as above. Gas formation in any quantity within 48 hours in the brilliant green bile lactose broth constituted a positive confirmed test. The enterococcus determinations were made in accordance with the "Recommended Procedure for Determining the Presence of Enterococci," by C. E. Winter and L. A. Sandholzer, Commercial Fisheries TL2, U. S. Fish and Wildlife Service, Washington, D.C., (Nov., 1946). From June 26 to July 19, three tubes were planted in the indicated number of dilutions for both the coliform and enterococcus determinations. From July 20 to August 19, five tubes

were planted in each dilution. The bacteriological determinations were made by Bacteriologist Harold F. Clark in the laboratories of the Environmental Health Center.

The results from the three sample points on the river beach were in such close agreement that the downstream sample point was discontinued on August 1. The center sample point in the swimming pool had been abandoned on July 20.

E. Epidemiological. The epidemiological data for the survey were obtained in a similar manner to that used in the Chicago study of 1948, reliance being placed upon a family record kept by the mothers of those families agreeing to co-operate. A family record form was prepared, for the housewife to record daily, by means of an indicated code, the swimming and illness record for each member of the household. Illness reports were confined to infections of the eye, ear, nose, throat and skin, and to gastrointestinal disturbances, as it was considered that these would be the diseases most likely to result from contact with polluted waters. If any individual had a chronic illness of these types, it was noted on the family record form by the field worker. It was believed improbable that there would be sufficient incidence of typhoid fever and similar enteric disease to permit correlation with bathing. An office-record card form was prepared on 5" x 8" file cards to record, for each co-operating family, the name, address, telephone number, and number of individuals in the household. This information also was entered on the family record form by the field worker.

The office-record form also provided for recording the date and method of all contacts with the family. Each co-operating family was assigned a file or serial number which was inserted on the family record form and corresponding office-record card. These forms and the accompanying instructions to the housewife are reproduced in Appendix B.

A group of 16 field workers were employed for the project. The majority of these were medical or premedical students and the others were university undergraduates majoring in social sciences. Two of the group were assigned to water sample collection and laboratory work and the others to canvassing the study area to secure and maintain the co-operation of the people in the work of the survey.

The epidemiological field workers were instructed in the purposes of the study and the methods to be followed in the work, with particular emphasis on the information needed and how it was to be entered on the forms. The workers were instructed that if a family could not be interviewed at the first attempt, a second call should be made on another day before abandoning the effort. It was felt that if the second attempt failed to produce an interview, any further effort would consume time better employed in seeking other families. An interview with a family was considered a chance to talk to an adult member and obtain either an agreement or refusal to co-operate. No particular effort was made to obtain co-operation from families where all members were over 65 years of age. Each worker was assigned a limited area of Dayton or Bellevue and a block of serial numbers for his use. To publicize the project and acquaint people with its purpose before the field worker called, news stories were fur-

nished to the Cincinnati metropolitan papers and to a local newspaper serving Dayton and Bellevue. A mimeographed flyer was also prepared which each field worker distributed at all dwelling places in his area a day or two before he started interviewing the people.

Each morning the field workers reported at the office, made a report on the previous day's work on a form prepared for the purpose, turned in the office-record forms for co-operating families, and picked up a supply of forms for the day. The individual worker reports were entered on a daily summary sheet and totaled on a form showing a running summary of progress.

The work of obtaining the desired number of co-operating families commenced June 26 and was completed July 12. Co-operation in the survey was secured from 2,297 families in a total of 144 man-days, or 16 families per worker per day. After July 12 the epidemiological field force was reduced to 7 for the remainder of the survey.

Analysis of the family size of the 1,215 co-operating families in Dayton showed 4.0 individuals per family. This would indicate a total of 4,500 families in the two communities on the basis of the 1950 Census. The results obtained in coverage of the communities is shown in the following tabulation:

Table 2 - Epidemiological Survey Coverage

	Number of Families	Per cent of In Area	Attempted Interviews	Interviews Made
In area (estimated)	4500	-	-	-
Attempted interviews	4238	93.8	-	-
Interviews completed	3409	75.7	80.5	-
Co-operating	2297	51.0	54.1	67.3

Attempts were made to call on each co-operating family at least twice during the progress of the survey, to maintain interest in the work and to answer any questions about entries to be made on the report form. Primary emphasis was placed on personal calls, but where these were impossible, telephone calls or letters were used. A total of 5,687 such personal calls were made on co-operating families prior to August 20 when collection of forms was started.

Water sampling was stopped August 20 and all available personnel were used to collect the family record forms. If no response was obtained in two attempts, a letter, with a franked addressed envelope, was left requesting that the form be completed and mailed. If there was no response to this letter within a reasonable time, a second letter requesting return of the form was mailed to the family. Copies of these letters are presented in Appendix B. Field work on the survey ended September 2 and all temporary employees were released. At this time a total

of 1,810 forms had been recovered. During the remainder of the month, 116 more forms were received by mail as a result of letters that had been left. By September 26 a total of 1,926 forms, or 83.9 per cent of all issued, had been recovered. Two hundred forty-four, or 12.7 per cent, of the recovered forms were received by mail as a result of "pickup letters" that were left at the homes. There were 371 forms that were not returned. These can be classified in four groups as shown below:

Table 3 - Non-Recovered Epidemiological Forms

Class	No. of Forms	Per cent of Non-Recovered	Per cent of Total Forms
Out of Area - Interviewed at Dayton Beach. Telephone contact impossible. No response to letter requesting return of form.	49	13.2	2.1
Unable to Re-interview - Moved out of area or address unknown. Mail returned as undeliverable.	21	5.7	0.9
Dropped from Record - Expressed refusal to co-operate or stated form lost during summer.	184	49.6	8.0
Uncollectible - No pickup interview. No response to collection letters.	117	31.5	5.1
Totals	371	100.0	16.1

III. SUMMARY OF DATA

A. Bacteriological

1. River Beach - The waters on the river beach (Dayton Beach) were sampled daily throughout the summer. Three sampling points were used on the beach until August 1. Because of the close agreement between the results at the three sample points, the downstream point was abandoned on August 1. A total of 143 individual beach water samples were taken in a period of 54 days and the coliform and enterococcus most probable numbers were determined on each. A summary of the results of the beach samples is given in Table 4, and the results obtained are shown in Table 1 of Appendix A.

Table 4 - Summary of Bacteriological Results - Dayton Beach

Date	Coliform MPN per 100 ml					Enterococcus MPN per 100 ml				
	Upstream	Center	Downstream	Beach Median	Beach Log Avg.	Upstream	Center	Downstream	Beach Median	Beach Log Avg.
			June 27 to					August 19		
Minimum	230	430		430	350	< 1.8	< 1.8		< 1.8	< 1.8
Lower Quartile	1,300	1,300		1,300	1,400	4.5	4.3		4.5	4.9
Median	2,800	2,300		2,300	2,900	19.	12.		13	16
Upper Quartile	7,900	4,800		4,800	4,700	49	33		41	38
Maximum	92,000	160,000		92,000	110,000	1,600	920		1,300	1,200
Log. Avg.	3,000	2,900		3,000	3,000	19	15		16	16
			June 27 to					July 31		
Minimum	230	430	430	430	350	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Lower Quartile	930	1,300	1,300	1,300	1,400	4.5	3.6	3.6	3.6	4.9
Median	1,700	2,300	2,300	2,300	2,700	21	9.1	11	9.1	16
Upper Quartile	4,300	4,300	4,300	4,300	4,400	43	33	23	39	37
Maximum	92,000	160,000	92,000	92,000	110,000	460	430	> 1,600	430	520
Log. Avg.	2,700	2,800	2,800	2,700	2,800	16	12	14	13	13

The data have been summarized for two different periods. The period June 27 - August 19 includes the results of all samples taken during the summer. The results were summarized by two methods, medians and logarithmic averages (or geometric means). The summarized results show that during the summer of 1949 the daily median coliform MPN per 100 ml. was between 1,300 and 4,800 for 50 per cent of the time and that the median value was 2,300. At times, coliform densities were found to be in excess of 6,000, but generally when this occurred, they exceeded this value several fold. In general, the enterococcus results fluctuated with the coliforms, but at much lower values. Because very little swimming was done after the end of July, the analysis of reported swimming and illness was confined to information recorded during the period June 28 through July 31. Therefore the bacteriological results have been summarized for the same period. Actually, there was very little difference between the results for the shorter period and those for the entire summer.

Daily coliform and enterococcus values and daily rainfall from Weather Bureau records are plotted in Figure 3. It will be noted that the high bacterial densities accompanied heavy rainfall of 1 inch per 24 hours or greater, or repeated rainfalls of less intensity.

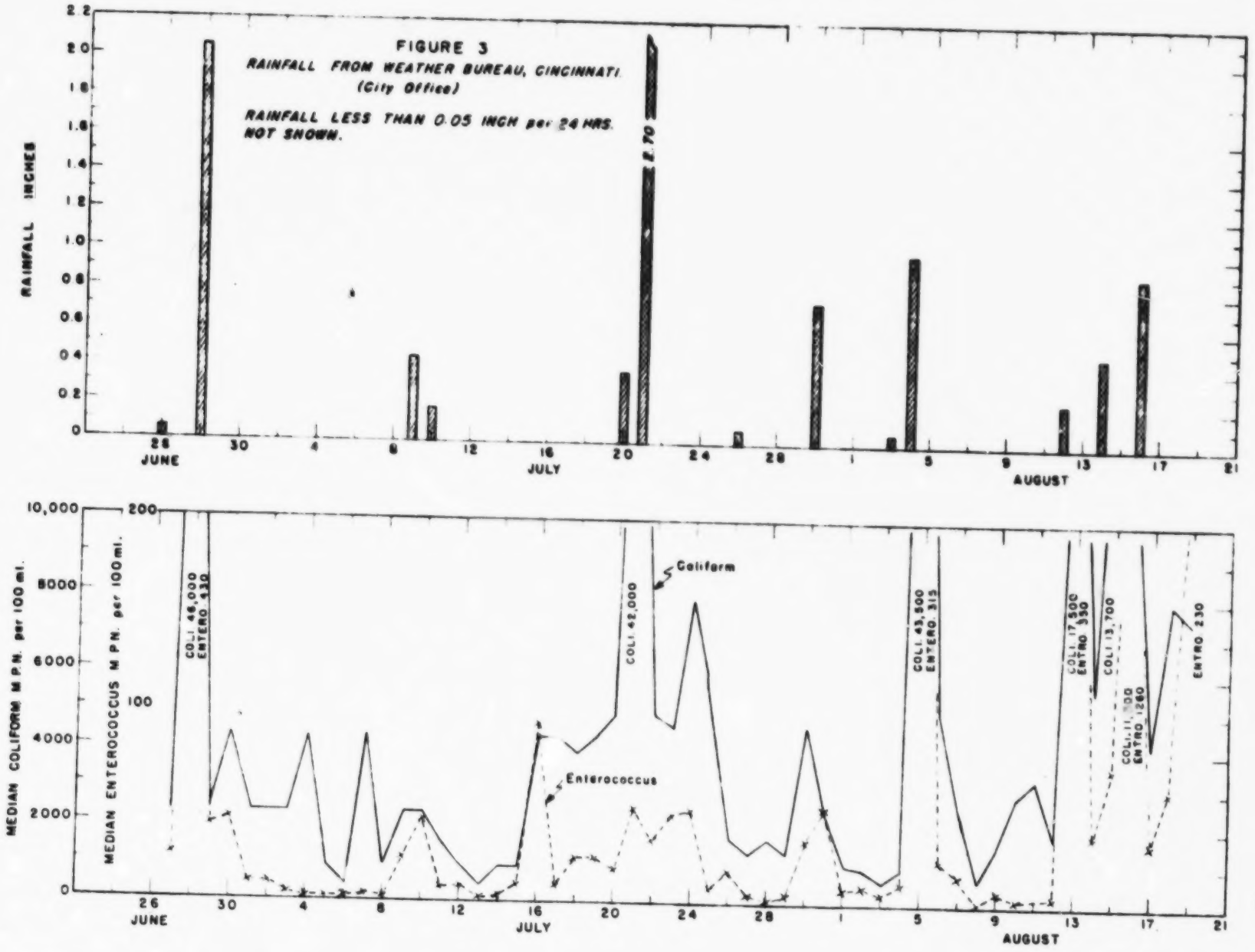
FIGURE 3
RAINFALL FROM WEATHER BUREAU, CINCINNATI
(City Office)
RAINFALL LESS THAN 0.05 INCH per 24 HRS.
NOT SHOWN.
RAINFALL INCHES
2.70
JUNE
JULY
AUGUST
MEDIAN COLIFORM M.P.N. per 100 ml.
MEDIAN ENTEROCOCCUS M.P.N. per 100 ml.
COLI 46,000
ENTERO 430
COLI 42,000
Coliform
Enterococcus
COLI 43,500
ENTERO 315
COLI 17,500
ENTRO 350
COLI 13,700
ENTRO 230

2. Shore Water Pollution - There are four sewers from Dayton that flow into the Ohio River within the city limits, with a total connected population equivalent estimated at 13,000 (data from Vogt, Ivers, Seaman and Associates, consulting engineers for Sanitation District No. 1, Campbell and Kenton Counties, Kentucky). From August 1 through August 19, a daily sample of the shore water was taken at the foot of Walnut Street, Dayton, near the west limits of the city, for comparison with the beach waters. Walnut Street is approximately 5,000 feet downstream from the lower end of Dayton Beach and is below the four sewer outlets. This stretch of river bank is not generally used for bathing, but on some occasions a few boys have been noted swimming in the area. The summarized comparison of the bacterial quality of the water on Dayton Beach and below the Dayton sewers is given in Table 5. Detailed results of the bacteriological determinations for the Walnut Street samples are shown in Table 2 of Appendix A.

Table 5 - Summarized Results. Effect of Raw Sewage Discharge on Ohio River Shore Waters. August 1 to 19, 1949.

	Coliform MPN/100 ml		Enterococcus MPN/100 ml	
	Dayton Beach Log Average	Walnut St., Dayton	Dayton Beach Log Average	Walnut St., Dayton
Minimum	590	79,000	< 1.8	240
Lower Quartile	1,000	160,000	4.5	790
Median	2,900	330,000	15.	1,400
Upper Quartile	7,500	790,000	59	2,400
Maximum	44,000	2,200,000	1,200	7,900
Log Average	3,300	360,000	24	1,400

3. Tacoma Park Pool - A summary of the results of the bacteriological determinations on the Tacoma Park pool samples for the period of June 27 through July 31 is given in Table 6. The results for each sample taken during the summer (June 27 - August 19) are shown in Table 3 of Appendix A.

Table 6 - Summary of Bacteriological Results, Tacoma Park Pool, June 27 to July 31, 1949

	MPN/100 ml - Pool Average		Chlorine Residual, ppm		pH
	Coliform	Enterococcus	Total	Free*	
Minimum	< 1.8	< 1.8	0.0	0.0	6.8
Lower Quartile	< 1.8	< 1.8	0.15	0.04	7.0
Median	< 3.0	< 3.0	0.27	0.35	7.1
Upper Quartile	< 3.0	< 3.0	0.63	0.75	7.2
Maximum	22.2	< 3.0	2.0	2.0	7.7

* July 7 to 31 only.

Results of examinations of the pool water for coliform bacteria were generally negative. On only 3 of 54 days, or in 3.9 per cent of the individual samples, were any coliform organisms detected. Enterococcus was not found at any time in the pool water. The hydrogen ion concentration (pH) varied between 6.8 and 7.7, showing a neutral or slightly alkaline water. After July 20 the chlorine residual of the water was maintained at higher levels than before, rising at times to 2.0 ppm of free chlorine.

B. Epidemiological

1. Introduction - Approximately 1,900 family calendar forms were returned at the conclusion of the field work of the study. Only about 30 of these had to be discarded because they contained insufficient information.

Hand tallying of a sample of the forms confirmed field observations that the amount of swimming in the river and the pool decreased greatly during the latter half of July and remained at a low level during August. This trial tabulation revealed that 95 per cent of all recorded swimming occurred before August 1. This is believed due to publicity concerning the incidence of poliomyelitis in the area and the public belief that it might be contracted by swimming. Because of the pronounced decline in swimming, it was decided to include in the epidemiological analysis only the data for the 34-day period from June 28 to July 31, inclusive, which is designated as the "period of study."

In all, usable records were obtained on 7,520 persons, 2,879 of whom swam on one or more days during the period of the study. Figure 4 shows the number of persons who reported swimming in the Ohio River, Tacoma Park pool, or at some other location each day for the period of study. The log averages of the coliform most probable number per 100 ml (MPN per 100 ml) at the three river beach sampling points for each day, and pertinent meteorological data from the Cincinnati office of the U. S. Weather Bureau, are also given.

In this figure, and in all of the following tabulations, swimming in or at "Ohio River," "River" or "River Beach" refers to swimming in

the Ohio River at, or in the immediate vicinity of, Dayton Beach as previously described in II-A. This gravel bar extends upstream about a half mile beyond the Dayton city limits, and some people who went swimming in this area considered it as a part of Dayton Beach. Swimming at other places in the Ohio River, however, was listed as at "other locations" or "elsewhere."

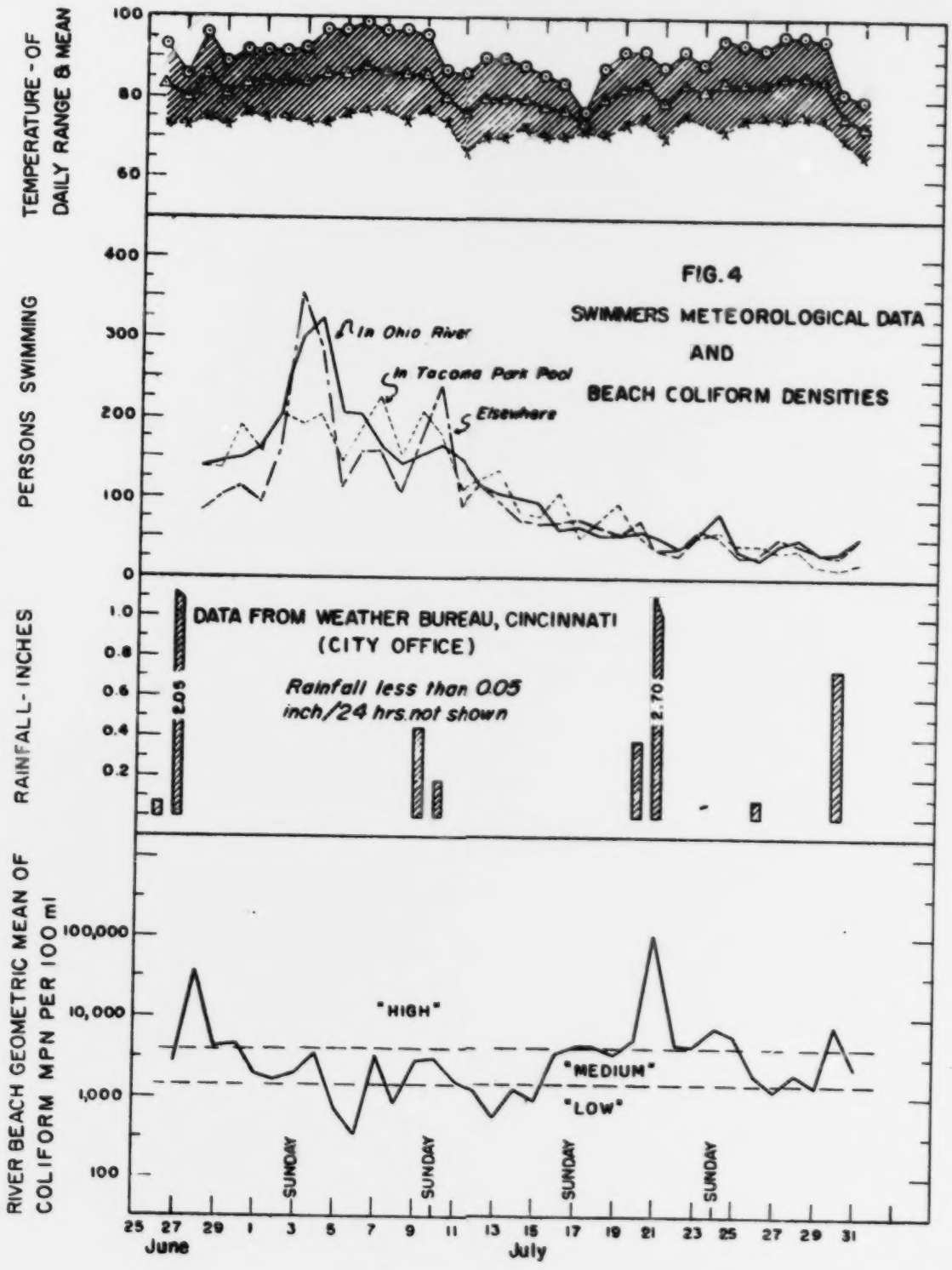

FIG. 4

SWIMMERS METEOROLOGICAL DATA AND BEACH COLIFORM DENSITIES

The decline in the amount of swimming is plainly shown by this figure. By the end of July the amount of swimming reported was less than a third of that for the first ten days of the month, with the Fourth of July week end excluded. The decline was not limited to any one location or even to the beach and the pool where the public could see samples being collected daily. The decrease "elsewhere" was practically identical to the decline for the Ohio River beach and Tacoma Park pool.

It might be expected that weather conditions might have a noticeable effect on the amount of swimming. However, there is no evident correlation between the decline in swimming and any recorded weather conditions. The temperatures of June 27 to July 9 and of July 19 to 31 are quite comparable. The rains that occurred, even the very heavy rain of July 20 and 21, are not accompanied by any noticeable drop in the number of bathers. With few exceptions the days of late June and all of July were hot. In July the monthly means of the daily maximum, minimum and mean temperatures were about 4.5 degrees above normal. Although not shown in Figure 4, the per cent of possible sunshine in July was about normal and the afternoon humidity was above normal except for five days, all before July 15.

2. Amount of Swimming and Illness in Surveyed Group - There were 2,879 individuals who reported swimming on one or more days during the period of study. Table 7 shows the "swimming status" of this group on each date of the period of study. The first three columns of fre-

quencies relate only to this group of swimmers and therefore do not give a complete count of persons "not yet in study," "not swimming" and "out of town." The remaining three columns are plotted in Figure 4. In general, the Ohio River beach was slightly more popular as a swimming location than was Tacoma Park Pool. During the last half of July, somewhat more swimming was done at unspecified locations than at either the river beach or the pool.

Table 7 - Daily Swimming Status of Persons Swimming One or More Days

Date	Number of Individuals					
	Not Yet in Study	In Study, Not in Town	In Study, In Town, Did Not Swim	Swimming		
				Ohio River	Tacoma Park Pool	Elsewhere
June 28	509	34	1978	136	139	83
29	440	37	2020	144	137	101
30	370	40	2015	149	191	114
July 1	231	47	2187	161	158	95
2	210	64	2042	203	203	157
3	172	77	1763	297	192	378
4	111	84	1875	324	201	284
5	83	69	2264	206	146	111
6	39	70	2225	203	185	157
7	14	79	2242	162	225	157
8	4	85	2392	141	153	104
9	4	82	2261	151	209	172
10	2	83	2208	165	178	243
11		88	2447	146	110	88
12		103	2424	114	120	118
13		100	2446	104	133	96
14		89	2539	98	82	71
15		89	2553	93	77	67
16		79	2565	58	108	69
17		72	2622	63	48	74
18		78	2612	53	73	63
19		73	2606	53	92	55
20		83	2610	56	59	71
21		81	2681	48	35	34
22		88	2688	39	29	35
23		82	2636	51	52	58
24		82	2513	80	58	146
25		83	2690	36	41	29
26		89	2694	25	41	30
27		88	2665	41	33	52
28		84	2668	49	37	41
29		91	2712	31	15	30
30		95	2707	34	13	30
31		110	2652	50	20	47
Total days of swimming				3764	3593	3460

Note: A total of 2,879 persons swam one or more days.
There were 4,641 persons who did no swimming.

Table 8 is a summarization by broad age groups of the frequencies that form the basis for many of the subsequent analyses. A breakdown of these figures by more restrictive age groups is given in Table 1 of Appendix C. In this table, persons with and without chronic illnesses are combined. This was done because the frequencies of swimming and illness for persons with chronic conditions were too small to be used separately. Another reason for combining the frequencies was because it was found that inclusion of persons with chronic illness would not alter the relation between swimming experience and illness. This table shows an interesting shift in preference for swimming location between age groups. The group from 5 to 19 years shows a preference for the pool rather than the river, but the group 20 years of age and over prefers to swim in the river. This is true both for males and females. In general, in the groups over 9 years of age, the males have a greater tendency toward swimming in the river than do the females.

Tables 9 and 10 present the basic rates of swimming experience and of illness incidence for all persons in the study, by age and sex.

Table 8 - Frequency Distribution of Persons, Person-Days, Swimming and Illness

Age Group	No. of Persons in Study	Person-Days of Observation	Days of Swimming				Number of Separate Illnesses
			Total	River	Pool	Elsewhere	
B o t h S e x e s							
Infants (under 5 yrs)	895	29,377	607	228	139	240	434
Children (5-19 yrs)	2,296	72,862	6,331	1,805	2,543	1,983	893
Adults (Over 19 yrs)	4,301	138,948	3,768	1,699	835	1,234	801
Age unknown	28	907	112	32	77	3	2
Total	7,520	242,094	10,818	3,764	3,594	3,460	2,130
M a l e s							
Infants (under 5 yrs)	461	15,208	347	117	80	150	210
Children (5-19 yrs)	1,160	36,792	3,399	1,085	1,355	959	473
Adults (over 19 yrs)	2,139	68,912	2,135	1,129	343	663	332
Age unknown	17	552	65	30	34	1	2
Total	3,777	121,464	5,946	2,361	1,812	1,773	1,017
F e m a l e s							
Infants (under 5 yrs)	434	14,169	260	111	59	90	224
Children (5-19 yrs)	1,136	36,070	2,932	720	1,188	1,024	420
Adults (over 19 yrs)	2,162	70,036	1,633	570	492	571	469
Age unknown	11	355	47	2	43	2	-
Total	3,743	120,630	4,872	1,403	1,782	1,687	1,113

Table 9 - Percentage of Total Person-Days for Swimming at Various Locations

Age Group	Males				Females			
	All Swimming	River	Pool	Elsewhere	All Swimming	River	Pool	Elsewhere
Persons with No Chronic Illness								
Under 5 years	2.3	0.8	0.5	1.0	1.9	0.8	0.4	0.6
5-9 "	5.6	1.5	2.2	1.9	6.4	2.1	2.0	2.3
10-19 "	11.6	3.9	4.6	3.1	9.0	2.0	3.9	3.1
20-44 "	4.0	2.1	0.6	1.3	3.1	1.0	0.9	1.1
45-64 "	1.2	0.8	0.1	0.2	0.5	0.3	0.2	0.1
Over 64 "	0.2*	0.2*	-	-	-	-	-	-
Age unknown	11.8	5.4	6.2	0.2*	13.2	0.6*	12.1	0.6*
All ages	4.9	2.0	1.5	1.5	4.1	1.2	1.5	1.4
Persons with One or More Chronic Illnesses								
Under 5 years	1.1*	0.4*	0.2*	0.4*	0.9*	0.2*	0.5*	0.2*
5-9 "	5.5	0.3*	2.4	2.8	4.4	0.8*	1.7*	1.9
10-19 "	8.9	3.1	4.0	1.8	12.8	1.0*	7.1	4.8
20-44 "	3.9	1.5	1.3	1.2	2.5	1.1	0.7	0.6
45-64 "	2.2	1.5	0.5*	0.2*	0.1*	-	0.1*	-
Over 64 "	-	-	-	-	-	-	-	-
Age unknown	...	...	...	...	...	...	...	...
All ages	4.3	1.6	1.5	1.2	3.0	0.8	1.2	0.9

Notes: * Based on less than 10 in the numerator
0.0 Percentage less than 0.05
- Numerator 0
... Denominator 0

Table 10 - Number of Illnesses of All Types Occurring During Study, per 100 Person-Days of Observation

Age Group	Persons Classified as Having:				All Persons
	No Chronic Illness		One or More Chronic Illnesses		
	Males	Females	Males	Females	
Under 5 years	1.3	1.6	2.6	2.3	1.48
5-9 "	1.4	1.1	1.7	2.3	1.29
10-19 "	1.1	1.1	2.7	2.3	1.19
20-44 "	0.5	0.6	1.4	2.1	0.68
45-64	0.2	0.3	0.7	1.0	0.32
Over 64 "	0.2*	0.3*	-	3.1*	0.33
Age unknown	0.4*	-	...	...	0.22*
All ages	0.8	0.9	1.5	2.0	0.88

Notes:
* Based on less than 10 in the numerator
0.0 Percentage less than 0.05
- Numerator 0
... Denominator 0

The population studied in Dayton and Bellevue did a little less than half as much swimming as was done by the Chicago families studied in 1948. The discrepancy was much greater than this among children. In Chicago, those of 5-9 years of age with no chronic illness did about four times as much swimming as the corresponding group in this study. In the present study, the males preferred the river beach over the pool and other swimming places, while among the females the river beach was the least favored.

The swimming frequencies for persons with one or more chronic illnesses are small, but in general the results show, as in the Chicago study, that these persons did about one-sixth less swimming than those reporting no chronic condition.

The incidence of illness, for all persons of all ages, was 0.88 per 100 person-days of observation. This is somewhat higher than the corresponding incidence of 0.76 per 100 person-days for the combined North and South areas at Chicago. The excess appears to have been chiefly in the children under 5 years of age, although generally the differences in illness rates were surprisingly small.

Table 11 shows the percentage distribution of swimming frequency at different locations for all individuals covered by the survey.

Table 11 - Percentage Distribution of Persons by Days and Location of Swimming

Sex	Total Per Cent	Days of Swimming								Number of Persons
		0	1-2	3-4	5-9	10-14	15-19	20-24	25-34	
Swimming in River										
Males	100.0	85.5	7.8	2.3	2.5	1.2	0.3	0.2*	0.2*	3,777
Females	100.0	89.5	6.4	1.5	1.5	0.8	0.1*	0.1*	0.1*	3,743
Swimming in Pool										
Males	100.0	82.6	11.8	3.0	1.9	0.4	0.2*	0.1*	0.1*	3,777
Females	100.0	80.0	14.9	2.7	2.0	0.2*	0.1*	0.1*	0.1*	3,743
Swimming Elsewhere										
Males	100.0	81.5	13.4	2.8	1.5	0.5	0.2*	0.1*	0.0*	3,777
Females	100.0	81.1	14.2	2.6	1.6	0.3	0.2*	0.1*	-	3,743

Notes:
* Based on less than 10 in numerator
0.0 Percentage less than 0.05
- Numerator 0
... Denominator 0

The average period of observation in this study was 32.2 days. Only 3.3 per cent of the total number of person-days of observation concerned the experience of individuals who went swimming 10 or more times, that is, once every 3 days or more frequently. While exact comparison with the Chicago study is not possible (owing to the use of different class intervals for tabulating the frequency of swimming during the two studies), in the Chicago study, 7.3 per cent of the experience was for people who went swimming 25 or more times in an average period of 57 days. This is equivalent to swimming at least every other day. It is apparent that the number of persons who swam at least one day in three, and who, therefore, had a frequent exposure to the swimming water, was much less in the Dayton-Bellevue study. Furthermore, the swimming in this latter study was often divided between the river where coliform densities were high, the pool where they were very low, and other places where the bacterial quality of the water was not known.

3. Observed vs. Expected Number of Illnesses in Several Swimming Groups - The first method of analysis of the epidemiological data from this survey was similar to that for the Chicago study, except that adjustment for possible differences in age composition of the groups under comparison was made by the "indirect" instead of the "direct" method. The latter involves computing illness rates by age for each subgroup (e.g., "pool swimmers with 1 to 4 days of total swimming") and applying these age-specific rates for the subgroup to the distribution by age of person-days of observation for all subgroups combined

(i.e., all persons in the study). In the "indirect method," age-specific illness rates for all subgroups combined are applied to the distribution by age of the person-days of observation for the subgroup under consideration. Then the results are added for all ages to give the "expected" number of illnesses for the subgroup. This is the number of illnesses that would be expected in this subgroup if the illness rates in all subgroups were the same. The ratio of the observed number of illnesses in the subgroup to the "expected" number is a measure of how the subgroup differs from all subgroups combined. The indirect method has advantages over the direct method when frequencies are small.

Since incidence of illness is usually a more sensitive index of the effect of environmental factors on health than is prevalence of illness, in this study all analyses were based on illness incidence.

To compare illness incidence among swimmers exposed to the relatively high coliform densities at the Ohio River beach with that among swimmers at the Tacoma Park Pool, it was necessary to group the individuals according to their preferred swimming localities. All individuals in the study were divided into five groups according to recorded swimming habits: first, "Swimmers Elsewhere," those who swam three or more times at some location other than the river or the pool (370 persons); second, "Nonswimmers," those who did no swimming in either the river or the pool (5,199 persons); third, "Pool Swimmers," those who did all or almost all of their swimming in the pool (1,080 persons); fourth, "River Swimmers," those who did all or almost all of their swimming in

the river (682 persons); and fifth, "Pool and River Swimmers," the residual group of those who did about equal amounts of swimming in the river and the pool (189 persons). For the purpose of this grouping, "almost all" swimming in the pool means that if a person swam five or more times in the pool, he could swim not more than twice at the river beach and still be included in the pool swimming group. In tabulating, the cards for the first group were withdrawn first so that all subsequent groupings excluded persons swimming "elsewhere" on three or more occasions. The second group, those who did not swim at all in the river or pool, may have swum once or twice at some other location, but the group is composed mostly of nonswimmers.

A comparison of the observed and expected incidence of illness in the various location-preference groups was made by two processes. In the first, the age-specific illness incidence rates for all persons in the study were computed to serve as a basis for computing the "expected" rates for the various swimming subgroups. These age-specific rates are given in Table 12.

Table 12 - Over-all Age-specific Illness Incidence Rates
Total Number of Illnesses per 100 Person-Days

All ages	Under 5 years	5-9 years	10-19 years	20-44 years	45-64 years	Over 64 years	Age Unknown
0.88	1.48	1.29	1.19	0.68	0.32	0.33	*0.22

* Based on less than 10 cases.

These age-specific rates from Table 12 were multiplied into the person-days distributed by age for each of 13 subgroups: Group 2, the nonswimmers; and then the third, fourth and fifth swimming groups, each subdivided into four categories according to the total amount of swimming at all locations. This provided an age-series of expected illnesses for each subgroup, their sum being the number of expected illnesses for the subgroup. The comparison of these "expected" numbers of illnesses and the actual number that occurred for each subgroup are shown in Table 13.

Table 13 - Observed vs. Expected Illness Incidence by Swimming Groups (First Method)

Swimming Group	Number of Person-Days	Number of Illnesses		Ratio of Observed to Expected	Observed Rate Per 100 Person-Days
		Observed	Expected		
1. Swimmers elsewhere		Not shown			
2. Nonswimmers	167,042	1,230	1,363	0.902	0.74
3. Pool Swimmers					
Total swim. days 1-4	28,500	346	304	1.138	1.21
" " " 5-9	4,563	83	49	1.694	1.82
" " " 10-19	1,310	42	15	2.800	3.20
" " " 20-34	303	3	3	1.000	1.00
Group Total	34,676	474	371	1.278	1.37
4. River Swimmers					
Total swim. days 1-4	14,155	154	135	1.141	1.08
" " " 5-9	4,524	45	43	1.047	1.00
" " " 10-19	2,539	21	24	0.875	0.83
" " " 20-34	609	0	5	-	-
Group Total	21,827	220	207	1.063	1.01
5. Pool and River Swimmers					
Total swim. days 1-4	4,171	43	45	0.950	1.03
" " " 5-9	1,718	19	19	1.000	1.11
" " " 10-19	536	7	6	1.167	1.31
" " " 20-34	97	3	1	3.000	0.31
Group Total	6,522	72	71	1.014	1.10
Combined Groups 3, 4 and 5					
Total swim. days 1-4	46,826	543	484	1.122	1.16
" " " 5-9	10,805	147	111	1.324	1.36
" " " 10-19	4,385	70	45	1.556	1.60
" " " 20-34	1,009	6	9	0.667	0.60
Group Total	63,025	766	649	1.180	1.22

From this table it is apparent that in general the ratio of observed to expected illnesses increased with the frequency of swimming, up to the last category. This is similar to results obtained in the Chicago study.

A comparison of illness incidence for Groups 3, 4 and 5 shows that the group that did most of their swimming in the pool apparently had the greatest amount of illness of all types combined. The incidence rates per 100 person-days of experience are: pool 1.37, river 1.01, and mixed 1.10.

As a confirmation of these results, a comparison was made by a second process (still using the principle of "indirect adjustment" previously described). Over-all illness incidence rates per 100 person-days, specific both for age and total amount of swimming done and based upon all persons in the study, were determined and are shown in Table 14.

Table 14 - Over-All Illness Incidence Rates per 100 Person-Days, by Age and Amount of Swimming

	Age Group							
	All Ages	Under 5 years	5-9 years	10-19 years	20-44 years	45-64 years	Over 64 years	Age Unknown
No Swimming								
Person-days	167,042	23,695	15,012	16,112	74,272	33,325	4,161	465
No.of illnesses	1,230	349	179	125	460	103	14	0
Incidence rate	0.74	1.47	1.19	0.78	0.62	0.31	0.34	-
1-4 Days of Swimming (All Locations)								
Person-days	51,569	4,562	9,021	18,188	17,978	1,585	31	204
No.of illnesses	592	74	126	224	160	8	0	0
Incidence rate	1.15	1.62	1.40	1.23	0.89	0.50	-	-
5-9 Days of Swimming								
Person-days	15,470	796	2,069	7,206	4,735	494	0	170
No.of illnesses	202	9	31	125	32	3	0	2
Incidence rate	1.31	1.13	1.50	1.73	0.68	0.61	-	1.18
10-19 Days of Swimming								
Person-days	6,544	290	1,084	3,276	1,727	167	0	0
No.of illnesses	93	2	13	61	17	0	0	0
Incidence rate	1.42	0.69	1.20	1.81	0.98	-	-	-
20-34 Days of Swimming								
Person-days	1,469	34	164	730	374	99	0	68
No.of illnesses	13	0	3	6	4	0	0	0
Incidence rate	0.88	-	1.83	0.82	1.07	-	-	-

These over-all incidence rates again show the previously observed tendency for the illness to increase with amount of swimming, excepting for those that swim almost daily.

The rates shown in Table 14 were multiplied into the person-days distributed by age and amount of swimming for each of the last three swimming groups. The "expected" numbers of illnesses so obtained were totaled for all ages and amounts of swimming to give an "expected" total for the swimming group. These totals are compared with the observed illnesses for the various groups in Table 15. It is to be noted that these totals of "expected" illnesses differ from those obtained by adding together the expected numbers for the four amount-of-swimming categories in the groups in Table 13.

Table 15 - Observed vs. Expected Illness Incidence by Swimming Groups (Second Method)

Swimming Group	No. of Person-Days	No. of Illnesses		Ratio Observed to Expected	Observed Rate per 100 Person-Days
		Observed	Expected		
1. Swimming Elsewhere			Not shown		
2. Nonswimmers			Not shown		
3. Pool Swimmers	34,676	474	424	1.118	1.37
4. River Swimmers	21,827	220	245	0.898	1.01
5. Pool-and-River Swimmers	6,522	72	82	0.878	1.10

The ratios of observed to expected illnesses in Table 15 show that the pool swimmers incurred more illness than would be expected on the basis of all individuals in the study. The river swimmers had less than their expected share.

4. Relation of Type of Illness and Swimming Location - During the study period, 2,130 separate cases of illness were reported. Table 16 shows the occurrence and distribution of these illnesses by type.

Table 16 - Reported Illnesses by Type

Type	Number of Illnesses	Per cent of All Illnesses
Eye	115	5.4
Ear	127	6.0
Eye and ear	2	0.1
Nose and throat	1029	48.3
Ear- or eye- and nose	17	0.8
Gastrointestinal	408	19.2
Skin	278	13.0
Other specified types	35	1.6
Other combinations	119	5.6
Total	2130	100.0

As the sanitary surveys and the coliform determinations (customarily used as an index of fecal pollution) indicated that the water at Dayton Beach was markedly polluted by domestic sewage discharges, it was recognized at the outset of the study that the incidence of gastrointestinal illnesses in the river swimming group would be a more sensitive criterion than the total illness incidence. The gastrointestinal illnesses among the entire population constitute only about one-fifth of the total, and the respiratory illnesses (involving the nose and/or throat) comprise nearly half of the total.

Observed-to-expected illness incidence and ratios were computed for three main type-of-illness subdivisions and five location-preference swimming groups by the second process previously mentioned. The type-of-illness subdivisions used were: (1) eye, ear, nose and throat; (2) gastrointestinal; and (3) other. In this computation, persons over 64 years of age and of unknown age were omitted. The swimming groups were the same as those used in Tables 13 and 15. The results of this analysis are shown in Table 17.

Table 17 - Observed vs. Expected Illness Incidence by General Illness Type Among Swimming Groups

Swimming Group	General Illness Types								
	Eye, Ear, Nose, Throat			Gastrointestinal			Other		
	Number of Illnesses		Ratio	Number of Illnesses		Ratio	Number of Illnesses		Ratio
	Observed	Expected		Observed	Expected		Observed	Expected	
1. Swimming Elsewhere	90	92.9	0.969	10	21.5	0.465	34	34.0	1.000
2. Nonswimmers	719	718.4	1.001	250	249.6	1.002	247	247.7	0.997
3. Pool Swimmers	326	267.0	1.221	73	78.4	0.931	81	80.0	1.012
4. River Swimmers	118	150.6	0.784	53	40.1	1.322	51	51.1	0.998
5. Pool and River Swimmers	28	51.4	0.545	18	14.0	1.286	16	16.9	0.947
Totals	1,281	1,280.3		404	403.6		429	429.7	

Note: Results are for persons under 65 years of age.

These results show that the excess of illness among pool swimmers is concentrated in the eye, ear, nose and throat class. In contrast, the river swimmers had 32 per cent more gastrointestinal illness than would be expected on the basis of experience of all groups combined, while illness of this type among pool swimmers was 7 per cent below expectancy.

Although these results would apparently indicate that swimming in polluted waters with coliform densities similar to those on Dayton Beach may cause increased gastrointestinal illness, there are relatively few cases involved. The difference between the number of observed and expected illnesses is only 12.9, and the standard error of the difference is probably somewhat greater than the square root of the expected number, which is 6.3, because the expected number of 40.1 is itself subject to some sampling error. This corresponds to a probability of 0.05 that such a result could occur as an effect of chance, and would indicate that the observed increased gastrointestinal illness among river swimmers was correlated with water quality. This increased incidence of gastroenteritis among the river swimmers may well be one of the most important findings of this study.

It should be noted that this excess of gastrointestinal illness, whether or not it is statistically significant, cannot readily be explained as an inherent tendency for the river swimmers to be less healthy than others in the study. As has been shown previously, this group of swimmers had less than the expected total number of illnesses.

5. Illness Following Swimming in the River - The punch cards used in analyzing the data were so designed that almost any desired analysis could be made of the swimming and illness on various dates. Conceding that persons who swam in the river possibly had different health characteristics from others in the study, it was still possible to determine whether swimmers at times of relatively high coliform densities tended to have more illness than those who swam when the coliform density was lower. It is presumed that there was no pertinent difference in the average river swimmer from day to day.

Statistical analysis showed that the coliform densities, expressed as geometric means of the most probable number per 100 ml, changed from day to day in a manner that could not be ascribed to chance and hence represented actual changes in the quality of the water. The results for the three sampling points at the river beach for an individual day, however, did not differ significantly.

In Table 18, the first 30 days of the 34-day study period are divided into ten independent periods of three days each and ranked in descending magnitude of coliform densities, the geometric mean of the coliform MPN being shown for each period in Column (1). Columns (3) and (5) indicate that, although there was a marked drop in swimming as noted

previously, those who continued to swim did so as frequently as in the early part of the season. The decrease was due to individuals who ceased swimming entirely and not to less frequent swimming by many persons. In Column (6) is shown the number of illnesses beginning in the <u>following</u> 3-day period among persons who swam one or more days in the period. Gastrointestinal illnesses are shown separately in Column (7), but it is evident that there are too few to permit analysis. The incidence rates for all types of illness are shown in the last two columns, computed per 100 persons swimming during the period and per 100 person-days of swimming. The latter rate is probably a better measure, as it takes account of the degree of exposure during the period. In this particular case, both of these illness incidence rates will rank the ten periods in the same order. It is evident from these data that this analysis shows no correlation between the bacterial quality of the river water and the illness incidence experienced by the bathers.

Table 18 - Relation of Illness Experience of 940 Ohio River Swimmers to Bacterial Quality of Bathing Water by 3-Day Periods Arranged in Descending Order of Coliform Densities

Geometric Mean of Coliform MPN	Date of 3-Day Periods 1951	No. of Persons Swimming	Person-Days of Swimming	Days of Swimming per Person	No. of Illnesses Among These Swimmers with Onset in Following Period		Illness Incidence per 100:	
					Total	Gastro-Intestinal	Persons	Person-Days
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9,570	7/19-21	95	157	1.65	2	0	2.1	1.3
8,920	6/28-30	258	429	1.66	14	2	5.4	3.3
5,380	7/22-24	117	170	1.45	4	0	3.4	2.4
3,980	7/16-18	123	174	1.41	2	0	1.6	1.2
2,400	7/25-27	68	102	1.50	1	0	1.5	1.0
2,000	7/7-9	291	454	1.56	20	8	6.9	4.4
1,740	7/10-12	285	425	1.49	9	0	3.2	2.1
1,700	7/1-3	415	661	1.59	24	3	5.8	3.6
957	7/4-6	489	773	1.50	16	4	3.3	2.2
872	7/13-15	189	295	1.56	6	3	3.2	2.0

Note: Analysis is based upon the 940 individuals who swam at least once at the river beach during the study period.

This number of persons is in excess of the 682 individuals in the group of "River Swimmers" who did all or nearly all of their swimming at the river beach.

The use of periods of three consecutive days, as in Table 18, may tend to conceal the effects of some of the high coliform densities which lasted for short periods of time. For this reason, illnesses among persons swimming in the river on each day and having an onset of illness exactly 1, 2 and 3 days after that day of swimming, were counted. This analysis was made for each of the first 30 days (June 28 to July 27) of the 34-day study period. The results for the 30 days were divided into three groups, or class intervals, according to the geometric mean of the coliform MPN on each day at the three sampling points. The data are shown in Table 19.

Table 19 - Illness Experience by Type of Illness for Certain Incubation Periods Following Swimming in Ohio River Water of Three Levels of Coliform Density

Class Interval of Geometric Mean of Coliform M.P.N. at River Beach	Mean Value Coliform M.P.N. in Interval	Number of Days in Interval	Total Person-Days of River Swimming in Interval	Swimmers Having Illness Onset on Specified Day After Swimming on a Day Included in Class Interval					
				3 days		2 days		1 day	
				Number	Per* Cent	Number	Per* Cent	Number	Per* Cent
All Types of Illness									
Less than 1,410	850	9	1,203	14	1.2	16	1.3	22	1.8
1,410 to 3,900	2,400	10	1,542	27	1.75	26	1.7	21	1.4
More than 3,900	7,750	11	855	12	1.4	5	0.6	8	0.9
Gastro-Intestinal Illness									
Less than 1,410	850	9	1,203	4	0.3	4	0.3	7	0.6
1,410 to 3,900	2,400	10	1,542	8	0.5	6	0.4	4	0.3
More than 3,900	7,750	11	855	2	0.2	0	-	0	-

* Per Cent = $\frac{\text{Swimmers Having Illness Onset}}{\text{Person-Days of Swimming}} = 100$

Obviously, any illness might be associated with any one of several possible prior days of swimming. However, if it is assumed that all illness incubation periods are exactly three days, it is possible to compare the incidence of illnesses having their onset exactly three days after swimming with the coliform densities on the days the swimming was done. Independent comparisons can be made on the assumptions of one and two day incubation periods. Each comparison must be made independent of the others, because it is possible for a single illness to come into the table more than once. As an example, a man might have swum on the 3rd and 4th of July and have become ill on the 6th. As the illness conceivably could have resulted from either exposure to the water, it is entered once as an illness with onset 3 days subsequent to swimming on the 3rd and once as an illness with onset 2 days subsequent to swimming on the 4th. These two days of swimming may be on the same or different lines of the table, depending on the coliform densities of the water, but they cannot be in the same column of the table. For this reason, vertical comparisons within the columns of the table do not encounter the difficulty of double entry of illnesses.

The results for all types of illness show no relation to the gradation of coliform densities. As in other tables, the numbers of gastrointestinal illnesses are too small to serve for a good comparison.

IV. CONCLUSIONS

(1) Because of the sharp reduction in the amount of swimming done by the study-population after July 10, and particularly because of the relatively few individuals who swam as frequently as once in three days, there was not enough exposure to the waters of the Ohio River and Tacoma Park pool to draw definite conclusions concerning the effect of variations in coliform densities in these waters on the health of the bathers.

(2) The study indicates that water of the quality found in the Ohio River during the summer of 1949 may cause an increase in gastroenteritis illness among bathers in excess of that experienced among bathers in unpolluted water. Gastrointestinal illnesses constituted only a fifth of the total reported, and the pool swimmers showed a tendency to have more illness of other types than did the river swimmers. These two circumstances tended to mask the effects of any increased gastroenteritis among river swimmers when total illness incidence was studied. It is apparent that an excess in gastroenteritis illness in any one group might have to be very great before it became apparent in the rates for illness of all types combined.

(3) The day-to-day variation in water quality in the river apparently was not associated with the incidence of all types of illness among the swimmers in a period of three days after swimming, although the sum of such illnesses was so small that random variation

would have obscured all but a very pronounced effect. The number of gastrointestinal illnesses was so small that no attempt was made to correlate them with the fluctuations in water quality.

(4) This study seemed to indicate that, even had there been no reduction in the amount of swimming during the summer, there would have been hardly enough cases of gastrointestinal illness within a reasonable incubation period after swimming to permit an analysis for correlation of gastrointestinal illness incidence and variations in water quality.

In planning future studies, it is necessary to consider carefully whether the present type of experiment, on the present scale, will ever be adequate to measure the effect upon health of swimming in waters of different bacterial quality where other than pronounced differences occur. Larger experiments of this type might be prohibitively expensive or otherwise infeasible, but those of the present size and type may not produce the frequencies required for adequate analysis in the marginal water quality areas.

APPENDIX A

Individual Laboratory Results

Table 1 - Bacteriological Results - Dayton Beach

Date 1949	Coliform M.P.N. per 100 ml.					Enterococcus M.P.N. per 100 ml.				
	Up-stream	Center	Down-stream	Beach Median	Beach Log Average	Up-stream	Center	Down-stream	Beach Median	Beach Log Average
June										
27	930	2,300	9,300	2,300	2,700	23	23	9.1	23	17
28	24,000	46,000	46,000	46,000	37,000	430	430	750	430	520
29	15,000	2,300	2,300	2,300	4,300	43	39	7.3	39	23
30	9,300	2,300	4,300	4,300	4,500	43	93	43	43	56
July										
1	1,500	2,300	2,300	2,300	2,000	3.6	9.1	15	9.1	7.9
2	930	2,300	2,300	2,300	1,700	9.1	3.6	9.1	9.1	6.7
3	1,500	2,300	2,300	2,300	2,000	9.1	3.6	3.6	3.6	4.9
4	4,300	4,300	2,300	4,300	3,500	3.6	< 3.0	< 3.0	< 3.0	< 3.0
5	930	930	430	930	720	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
6	230	430	430	430	350	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
7	4,300	2,300	4,300	4,300	3,500	7.3	3.6	< 3.0	3.6	3.7
8	1,500	430	930	930	850	< 3.0	3.6	< 3.0	< 3.0	< 3.0
9	930	2,300	9,300	2,300	2,700	23	23	43	23	28
10	1,500	2,300	7,500	2,300	3,000	43	43	43	43	43
11	1,500	1,500	1,500	1,500	1,500	7.3	7.3	3.6	7.3	5.8
12	930	750	2,100	930	1,100	< 3.0	9.1	9.1	9.1	5.5
13	930	430	430	430	560	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
14	2,300	930	930	930	1,300	3.6	3.6	9.1	3.6	4.9
15	930	930	930	930	930	9.1	9.1	3.6	9.1	6.7
16	2,300	4,300	4,300	4,300	3,500	93	93	240	93	130
17	4,300	4,300	4,300	4,300	4,300	460	9.1	7.3	9.1	31
18	3,900	9,300	2,300	3,900	4,400	93	23	23	23	37
19	4,300	2,300	4,300	4,300	3,500	23	9.1	23	23	17
20	4,900	4,900	4,900	4,900	4,900	23	17	11	17	16
21	92,000	160,000	92,000	92,000	110,000	49	33	>1,600	49	170
22	4,900	7,000	3,300	4,900	4,800	21	49	33	33	32
23	7,900	4,600	2,300	4,600	4,400	46	22	62	46	40
24	7,900	11,000	4,900	7,900	7,500	49	110	49	49	64
25	7,900	4,900	4,600	4,900	5,600	7.8	7.8	23	7.8	11
26	1,700	1,700	2,600	1,700	2,000	33	17	11	17	18
27	1,300	1,700	920	1,300	1,300	7.8	4.5	4.5	4.5	5.4
28	1,300	3,300	1,700	1,700	1,900	13	2.0	2.0	2.0	3.7
29	1,700	1,300	1,300	1,300	1,400	4.5	4.5	13	4.5	6.4
30	4,600	23,000	3,100	4,600	6,900	49	33	17	33	30
31	2,300	2,300	2,300	2,300	2,300	49	49	23	49	39

(Continued on next sheet)

Table 1, Continued.

Date 1949	Coliform M.P.N. per 100 ml.					Enterococcus M.P.N. per 100 ml.				
				Beach					Beach	
	Up-stream	Center	Down-stream	Median	Log Average	Up-stream	Center	Down-stream	Median	Log Average
Aug.										
1	1,300	790	-	1,000	1,000	7.8	7.8	-	7.8	7.8
2	1,100	790	-	950	930	7.8	11	-	9.4	9.3
3	490	700	-	600	590	7.8	< 1.8	-	4.6	3.2
4	790	1,100		950	930	13	7.8		10	10
5	54,000	35,000		45,000	44,000	350	280		320	310
6	3,300	6,400		4,900	4,600	23	23		23	23
7	2,300	2,300		2,300	2,300	17	13		15	15
8	490	700		600	590	< 1.8	< 1.8		< 1.8	< 1.8
9	1,300	1,700		1,500	1,500	2.0	13		7.5	6.8
10	3,300	2,300		2,800	2,800	2.0	4.5		3.3	3.0
11	4,900	1,700		3,300	2,900	4.5	4.0		4.3	4.3
12	2,200	1,300		1,800	1,700	4.5	4.5		4.5	4.5
13	22,000	13,000		18,000	17,000	350	350		350	350
14	7,900	3,300		5,600	5,100	49	23		36	34
15	24,000	3,300		14,000	8,900	130	13		72	41
16	13,000	9,500		11,000	11,000	1,600	920		1,300	1,200
17	4,900	3,300		4,100	4,000	33	33		33	33
18	4,900	11,000		8,000	7,400	70	49		60	59
19	7,000	7,900		7,500	7,500	240	220		230	230

Note: < 1.8 indicates indeterminate, but less than 1.8
Assumed to be 1.3 in computation of means.

< 3.0 indicates indeterminate, but less than 3.0
Assumed to be 2.0 in computation of means.

> 1600 indicates indeterminate, but greater than 1600.
Assumed to be 2400 in computation of means.

Table 2 - Bacteriological Results, Ohio River, at Dayton Beach and Walnut Street

Date 1949	Coliform MPN/100 ml.		Enterococcus MPN/100 ml.	
	Dayton Beach Log Average	Walnut St. Dayton	Dayton Beach Log Average	Walnut St. Dayton
Aug. 1	1,000	160,000	7.8	1,600
2	930	330,000	9.3	240
3	590	230,000	3.2	2,400
4	930	79,000	10	490
5	44,000	130,000	310	1,400
6	4,600	240,000	23	790
7	2,300	230,000	15	1,300
8	590	790,000	< 1.8	920
9	1,500	790,000	6.8	3,300
10	2,800	790,000	3.0	7,900
11	2,900	2,200,000	4.3	2,400
12	1,700	790,000	4.5	4,900
13	17,000	330,000	350	780
14	5,100	130,000	34	1,100
15	8,900	790,000	41	1,700
16	11,000	330,000	1,200	2,300
17	4,000	79,000	33	450
18	7,400	460,000	59	790
19	7,500	1,300,000	230	2,400
Minimum	590	79,000	< 1.8	240
Lower Quartile	1,000	160,000	4.5	790
Median	2,900	330,000	15	1,400
Upper Quartile	7,500	790,000	59	2,400
Maximum	44,000	2,200,000	1,200	7,900
Log Average	3,300	360,000	24	1,400

Note: Walnut Street is approximately 5,000 feet downstream from lower end of Dayton Beach.

Between Dayton Beach and Walnut St. there are 4 sewers discharging raw sewage to the river from an estimated population equivalent of 13,000.

Table 3 - Bacteriological Results, Tacoma Park Pool

Date 1949	Coliform MPN/100 ml			Enterococcus MPN/100 ml			Chlorine Residual ppm		pH
	Deep End	Center	Pool Avg.	Deep End	Center	Pool Avg.	Total	Free	
June 27	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.15		7.0
28	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.25		7.1
29	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.17		7.7
30	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.17		7.0
July 1	9.1	<3.0	5.2	<3.0	<3.0	<3.0	0.15		7.2
2	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.27		7.1
3	<3.0	3.6	2.5	<3.0	<3.0	<3.0	0.30		7.5
4	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.35		7.4
5	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.25		7.3
6	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.12		7.3
7	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0	0.0	7.3
8	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0	0.0	7.5
9	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.15	0.025	7.3
10	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.08	0.0	7.2
11	9.1	<3.0	5.2	<3.0	<3.0	<3.0	0.1	0.075	7.2
12	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.15	0.15	7.1
13	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.075	0.05	7.2
14	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.37	0.35	7.0
15	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.37	0.37	7.0
16	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.27	0.17	7.0
17	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.63	0.5	6.9
18	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.1	0.0	7.1
19	<3.0	43	22.2	<3.0	<3.0	<3.0	0.075	0.0	7.0
20	<1.8		<1.8	<1.8		<1.8	0.4	0.4	6.9
21	<1.8		<1.8	<1.8		<1.8	0.5	0.5	6.3
22	<1.8		<1.8	<1.8		<1.8	0.75	0.75	6.9
23	<1.8		<1.8	<1.8		<1.8	0.75	0.75	7.0
24	<1.8		<1.8	<1.8		<1.8	0.35	0.35	6.9
25	<1.8		<1.8	<1.8		<1.8	0.2	0.2	7.0
26	<1.8		<1.8	<1.8		<1.8	0.75	0.75	7.2
27	<1.8		<1.8	<1.8		<1.8	1.0	0.75	7.1
28	<1.8		<1.8	<1.8		<1.8	1.0	1.0	6.3
29	<1.8		<1.8	<1.8		<1.8	1.4	1.4	7.0
30	<1.8		<1.8	<1.8		<1.8	2.0	2.0	7.0
31	<1.8		<1.8	<1.8		<1.8	2.0	2.0	6.3

Table 3. (Continued)

Date 1949	Coliform MPN/100 ml Deep End	Coliform MPN/100 ml Center	Coliform MPN/100 ml Pool Avg.	Enterococcus MPN/100 ml Deep End	Enterococcus MPN/100 ml Center	Enterococcus MPN/100 ml Pool Avg.	Chlorine Residual ppm Total	Chlorine Residual ppm Free	pH
Aug. 1	<1.8		<1.8	<1.8		<1.8	2.0	2.0	6.8
2	<1.8		<1.8	<1.8		<1.8	1.3	1.3	6.6
3	<1.8		<1.8	<1.8		<1.8	1.4	1.4	6.6
4	<1.8		<1.8	<1.8		<1.8	1.4	1.4	7.0
5	<1.8		<1.8	<1.8		<1.8	1.4	1.4	6.9
6	<1.8		<1.8	<1.8		<1.8	2.0	2.0	6.6
7	<1.8		<1.8	<1.8		<1.8	2.0	2.0	6.7
8	<1.8		<1.8	<1.8		<1.8	0.5	0.5	6.8
9	<1.8		<1.8	<1.8		<1.8	2.0	2.0	6.9
10	<1.8		<1.8	<1.8		<1.8	1.4	1.4	7.2
11	<1.8		<1.8	<1.8		<1.8	1.0	1.0	7.1
12	<1.8		<1.8	<1.8		<1.8	0.5	0.5	7.2
13	<1.8		<1.8	<1.8		<1.8	1.4	1.4	7.4
14	<1.8		<1.8	<1.8		<1.8	1.4	1.4	7.2
15	<1.8		<1.8	<1.8		<1.8	1.0	1.0	7.0
16	<1.8		<1.8	<1.8		<1.8	0.5	0.5	7.1
17	<1.8		<1.8	<1.8		<1.8	0.75	0.75	6.9
18	<1.8		<1.8	<1.8		<1.8	2.0	2.0	7.0
19	<1.8		<1.8	<1.8		<1.8	0.5	0.5	6.8

Note: Center sample discontinued July 20
Five tubes planted in each dilution starting July 20
For averaging, <3.0 is assumed to be 1.3

APPENDIX B

Survey Forms.

BATHING WATER SURVEY
BELLEVUE - DAYTON

Instructions to Epidemiological Aides

A definite area will be assigned to each Aide. It will be his responsibility to see that every family living in the area is contacted if possible. If you are unable to make contact on the first call, make at least a second call on another day. A notebook with suggested form is provided to help you route your work and provide you with a record of results.

Before attempting to make any family contacts in the area assigned to you, go through the entire area leaving a copy of the yellow flyer announcing the survey at the door of each family dwelling unit. These are not to be put into mailboxes, because of postal regulations. They should be tucked behind the doorknob, or slipped under the door or inside the screen door. If these methods are not possible, they may be left on the door sill or step.

Each household unit that agrees to co-operate in the survey should be furnished with a calendar form and mimeographed letter, "Dear Participant." The general purpose of the survey should be explained and the method of filling out the calendar form should be described in detail with illustrations. An "Office Record Form" should be filled out at the same time to ensure accuracy of the entries.

Calendar Form

The following information should be secured at the time of the visit and entered on the calendar form by you:

File Number - assigned consecutively, from the block of numbers furnished to you, to each form issued.

Family Name - last name of head of household.

Address and Telephone - the street and number, name of city (Bellevue or Dayton), apartment number (if an apartment house), and telephone number. Note that there are no postal zones in Bellevue and Dayton and this item does not apply.

Members of Household - The first and middle name (or initial) of the head of the household should be recorded first. Each member of the household having the same last name as the head of the household

should be listed in a similar manner. The full names, including last name, of other members of the household should be entered.

Example:
Family name - Brown
Members of household - John E.
Mary B.
(Mrs.) Margaret F. Jones

Age - the age in years to the nearest birthday. If the household occupants in the older age groups do not wish to state their exact ages, they may be recorded as "plus 40" or "plus 50," etc. Infants under one year should be recorded as "minus 1."

Sex - use appropriate first letter to denote male or female.

Relationship - opposite the name of each member of the household, his or her relationship to the "head" or first person listed should be noted as follows:

Wife, son, daughter, (including stepson or stepdaughter), son- or daughter-in-law, father, mother, father- or mother-in-law, brother or sister (including in-laws). All other members of the household should be designated "none" regardless of relationship.

Chronic Illness - the interviewer should determine whether or not there is any history of chronic illness in any member of the family. This should be recorded opposite the name of the individual affected in accordance with the following code:

I - chronic eye infection
E - chronic ear infection
N - chronic sinusitis, hay fever, other nasal allergy
T - chronic bronchitis
S - chronic skin allergy
G - chronic gastrointestinal infection
A - chronic asthma.

Entries - actual entries should be made on the calendar form starting with June 27 on the basis of information supplied by the householder at the time of the first visit. Use this entered information to illustrate the method of filling out the form.

It is preferred that the calendar form be posted in a conspicuous place on the wall, if possible, to ensure that it is not forgotten. The kitchen is suggested as a desirable location. You are furnished with Scotch tape for attaching it, as this will not mar painted wall surfaces.

Office Record

The information contained on the office card should be filled in before leaving the calendar form and must agree with similar information on the calendar form. The date of the visit should be recorded in the upper left hand box. Sign your name in the upper right corner.

Scheduled Absence - means any planned absence of the family for 10 days or more that is known at the time of the interview. The dates of such scheduled absence (if any) should be noted on the card. This is in order that we will not attempt to revisit the family during the period that they will be away.

Field Worker Daily Report

This form is to be filled out by you each night and returned to this office with all completed Office Record cards. The information from your notebook will enable you to make out this record. This information is needed so that we may know how the work is progressing.

General

When you have completed the canvass of the area assigned to you, inform this office and a new area will be assigned until both communities have been completely covered. A new block of file numbers will be assigned to be used in the new area.

BATHING WATER SURVEY

File No. O F F I C E R E C O R D

Address _____ _____ _____
No. Street City Zone Apt. No.

Head of Household _____ _____ _____
Last Name First Name Initial

Number in Household _____ Telephone No. _____

DATES COVERED

Visit											
Telephone											
Circular											

Scheduled Absence _____

BATHING WATER SURVEY
DAYTON BEACH, KY.

Dear Participant:

The purpose of this survey is to secure reliable information on the effect, if any, of bathing in the Ohio River in the Dayton area on the health of the bathers. The information obtained will be used eventually to help establish a sound standard of bathing water quality. To accomplish this purpose, two items are especially important. First, a sufficiently large population group residing near a bathing beach must be surveyed to give significant results; and, second, the participants must be willing to make the daily entries on the survey form carefully and accurately and return the form when completed.

We have selected the area in which you reside because it was felt that the location and the type and size of the resident population would meet these requirements in this area. Your co-operation in maintaining an accurate record on the calendar form is urgently requested.

The following explanations are made for your guidance in using the survey form which has been furnished to you.

Entries - An entry should be made opposite "swim" and "illness" for each member of the household for each day. The letter symbols shown at the bottom of the form should be used in making the entries in the appropriate blocks.

Out of Town - If any member of the household is out of the city for more than three (3) consecutive days, dash lines (-) should be placed opposite his name in both the "swim" and "illness" lines for each day he is away.

Swimming Record - Make some entry for each day, not just for days there was some illness.

When a member of the household visits the beach for purposes of picknicking, sunbathing, etc., but does not go in the water, the entry for the day should be (x), meaning no swimming.

Swimming includes diving, wading, or any other activity in which the individual is actually in the water at one of the specified locations.

Illness Record - Put down any illness of the types given in the list even if you think that it was not connected with swimming.

If any ailment continues for several days, the appropriate symbol should be entered in the "illness" line for each day. Also if a person has more than one of the ailments listed, an entry for each should be made in the "illness" block for that day.

The following example is given to show how a form might be made out:

Swim	X	S	X	O	X	X	S	-	-	-	-	X	T
Illness	X	X	X	X	E	E	X	-	-	-	-	X	TE

From time to time we shall try to reach you by telephone or by another visit. However, we sincerely urge you to maintain a complete and accurate record on the survey form provided. At the end of the survey a visit will be made to pick up the completed form. If we fail to pick up the form by September 15, please mail it to: Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio.

Your co-operation and assistance in making this survey is greatly appreciated.

Sincerely yours,

Campbell County Health Department
Kentucky State Department of Health
U. S. Public Health Service

BUREAU OF BUDGET
FORM NO. 68-R608
PHS -1251(SAE)

Form No.
FEDERAL SECURITY AGENCY
Public Health Service
Environmental Health Center
Cincinnati, Ohio
(May 1949)

BATHING WATER SURVEY
CALENDAR FORM

Budget Bureau No.
Approval Expires

Notes: 1. For further explanation of any entry use the back of this form. Put a footnote number on the front next to the entry and also on the back next to explanation.
2. If you move away or, if this calendar is not called for by Sept. 15, please mail it to Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio.
3. For further information telephone Walnut 2300 - Ext. 574

File No.____ Tel. No.____ City____
Family Name ____ Apt. No.____
Address____ No.____ Street____ Zone____

No.		Age	Sex	Relationship	Chronic Illness	Record	June 28	29	30	July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1						Swim																											
						Illness																											
2						Swim																											
						Illness																											
3						Swim																											
						Illness																											
4						Swim																											
						Illness																											
5						Swim																											
						Illness																											
6						Swim																											
						Illness																											

No.	First Name	Record	July 25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	September 1	2	3	4	5	6	7
1		Swim																																												
		Illness																																												
2		Swim																																												
		Illness																																												
3		Swim																																												
		Illness																																												
4		Swim																																												
		Illness																																												
5		Swim																																												
		Illness																																												
6		Swim																																												
		Illness																																												

Make some entry on swimming and on illness for every day for each member of the family as follows:

Swimming

- x No swimming.
- S Swimming in Ohio River at Dayton Beach.
- T Swimming in Tacoma Park pool.
- M Swimming in Mertz Grove pool (Ross, Ky.).
- O Swimming at any other location.
- - Out of town for more than 3 consecutive days.

Put down whether there was any swimming or not for every day, not just for days there was some illness.

Illness

- x No illness of any kinds listed below.
- I Eye inflamation, styes, watery eyes.
- E Ear infection, earache, or any other trouble with ears.
- N Nose or head colds, sinus trouble, persistent stopped-up-nose.
- T Throat inflamation, sore throat, persistent cough.
- S Skin infection, skin rash, open sores, itching.
- S Stomach or intestinal upset, diarrhea, vomiting, nausea.
- - Out of town for more than 3 consecutive days.

Put down any illness of the types given in the list even if you think it was not connected with swimming.

PUBLIC HEALTH SERVICE
BATHING WATER SURVEY

A field worker from the Public Health Service Bathing Water Survey called on you to collect the record form that you have been keeping for us, but unfortunately was unable to find you at home.

It is essential to this study that these records be completed and returned without delay so that the information may be tabulated for study.

Will you please see that your record is completed and then put in the attached franked envelope (which does not require postage) and mailed at once?

Again we wish to thank you for the help that you have given to this work during the summer.

Sincerely yours,

(FORM COLLECTION "NON-CONTACT LETTER)

Dear Participant:

Several days ago a field worker from the Public Health Service called to pick up the Bathing Survey form which you have been keeping for us this summer.

As you were not home, he left a letter requesting you to mail the form in the envelope that was enclosed, and which did not require postage.

To date, we have not received this form and fear that you may not have received the letter or have lost the return envelope.

It is essential to this study that these records be completed and returned without delay so that the information may be tabulated for study.

Will you please see that the information requested on the chart is brought up to date, put the chart in the envelope enclosed with this letter, and drop it in the nearest mailbox as soon as possible? No postage is needed on the envelope.

Again we wish to thank you for the help that you have given to this work during the summer.

Very truly yours,

(FORM COLLECTION "REMINDER" LETTER)

APPENDIX C

Miscellaneous Data

Table 1 - Frequency Distribution by Sex and Age of Persons, Person-Days, Swimming and Illness

Age Group	Number of Persons in Study	Person-Days of Observation	Days of Swimming				Number of Separate Illnesses
			Total	River	Pool	Elsewhere	
B o t h S e x e s							
Under 5 years	895	29,377	607	228	139	240	434
5-9 "	850	27,350	1,635	473	581	581	352
10-19 "	1,446	45,512	4,696	1,332	1,962	1,402	541
20-44 "	3,067	99,086	3,432	1,485	777	1,170	673
45-64 "	1,105	35,670	333	211	58	64	114
Over 64 "	129	4,192	3	3	-	-	14
Age unknown	28	907	112	32	77	3	2
Total	7,520	242,094	10,818	3,764	3,594	3,460	2,130
M a l e s							
Under 5 years	461	15,208	347	117	80	150	210
5-9 "	438	14,137	797	205	314	278	196
10-19 "	722	22,655	2,602	880	1,041	681	277
20-44 "	1,478	47,573	1,881	953	312	616	277
45-64 "	599	19,330	251	173	31	47	52
Over 64 "	62	2,009	3	3	-	-	3
Age unknown	17	552	65	30	34	1	2
Total	3,[illegible]	121,464	5,946	2,361	1,812	1,773	1,017
F e m a l e s							
Under 5 years	434	14,169	260	111	59	90	224
5-9 "	412	13,213	838	268	267	303	156
10-19 "	724	22,857	2,094	452	921	721	264
20-44 "	1,589	51,513	1,551	532	465	554	396
45-64 "	506	16,340	82	38	27	17	62
Over 64 "	67	2,183	-	-	-	-	11
Age unknown	11	355	47	2	43	2	-
Total	3,743	120,630	4,872	1,403	1,782	1,687	1,113